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(54) **Tufted pile carpet and method of preparation**

(57) A method for the manufacture of a tufted pile carpet is disclosed. The method comprises contacting a polyolefin composition of at least one grafted polymer selected from polyolefin, olefin copolymer and olefin terpolymer with a tufted primary carpet backing. The tufted primary carpet backing is comprised of fibres selected from at least one of polyamide fibres, polyester fibres, polypropylene fibres, acrylic fibres, rayon fibres and natural fibres. The grafted polymer is selected from at least one of homopolymers of ethylene and propylene, copolymers of ethylene and propylene, terpolymers of ethylene, propylene and diene and copolymers of ethylene with at least one of a C₃ - C₁₀ hydrocarbon alpha-olefin, vinyl acetate, alkyl acrylate or alkyl methacrylate that has been grafted with at least one monomer selected from ethylenically unsaturated dicarboxylic acids and anhydrides thereof. The polyolefin composition is heated to a temperature above the melting point of the polyolefin composition, and maintained in contact with the tufted primary carpet backing, at a temperature above the melting point of the polyolefin composition under a pressure and for a period of time sufficient to cause the polyolefin composition to flow around the fibres of the tufted carpet backing. The polyolefin composition is maintained in contact with the tufted primary carpet backing and at a temperature above the melting point of the polyolefin composition for a further period of at least 30 seconds. The resultant carpet is then cooled below the melting point of the composition. The polyolefin composition may also be placed between a tufted primary carpet backing and a secondary carpet backing and contacting the composition. Tufted pile carpets wherein such a tufted primary carpet backing has been stabilized with such a polyolefin composition are also disclosed.

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TUFTED PILE CARPET AND METHOD OF PREPARATION

0 The present invention relates to a method for the manufacture for a tufted pile carpet, and to the resultant carpet. In particular, the invention relates to the use of grafted polyolefin, grafted olefin
5 copolymers and grafted olefin terpolymers, and mixtures thereof, including blends of such grafted polymers with un-grafted polyolefins, olefin copolymers and olefin terpolymers, and mixtures thereof, which may be collectively referred to hereinafter as "polyolefin
10 compositions", in the manufacture of tufted pile carpet.

The manufacture of tufted pile carpet normally involves the tufting of the pile into a primary carpet backing using a needle punching operation. Techniques for forming the tufted pile in primary backing are well
15 known. Subsequent to any washing and dyeing of the primary carpet backing, it is subjected to a lamination procedure in which a secondary carpet backing is laminated to the underside of the tufted primary carpet backing. Primary carpet backings for tufted pile carpets
20 are typically woven or nonwoven fabric made from one of more natural or synthetic fibres or yarns. Examples of primary carpet backing are jute, wool, polypropylene, polyethylene, polyamide, polyesters and rayon. Films of synthetic polymers may also be used to form the primary
25 carpet backing e.g. polypropylene, polyethylene including copolymers of ethylene with hydrocarbon alpha-olefins, and copolymers of propylene with minor amounts of ethylene.

The primary carpet backing is normally coated with a
30 polymeric latex to encapsulate the yarn tufts and to provide an adhesive surface for the secondary carpet backing material. The secondary carpet backing may be, for example, a thermoplastic film or a woven or nonwoven fabric made from polypropylene, polyethylene including
35 copolymers of ethylene with hydrocarbon alpha-olefins, or copolymers of propylene with minor amounts of ethylene or

natural fibres such as jute. The lamination is normally conducted using a latex adhesive.

However, one disadvantage of carpets composed of such latex compositions is that after these carpets have been discarded, it is difficult to shred and break them down into their component parts for recycling.

Hot-melt adhesives are also used in the lamination of primary carpet backings to secondary carpet backings, in place of the latex. The hot melt adhesive is normally formed from a base polymer that is a thermoplastic polymer selected such that the hot melt adhesive composition has a sufficiently low melting or softening point and viscosity in order to flow readily at the finishing temperatures used in the carpet manufacture operation.

In typical hot-melt adhesive compositions, the base polymer comprises at least 5% by weight, but more typically 40-50% by weight, of the hot melt adhesive composition. The base polymer of the hot melt adhesive is blended with a modifying resin which is used to impart wetting and tackifying properties. Modifying resins are generally low melting, low molecular weight materials, examples of which include polyterpene and other synthetic and naturally occurring resins and rosins, e.g. unmodified or hydrogenated, functionalized or otherwise modified aliphatic, aromatic or heterocyclic materials, including coumarone-indene resins, terpene-phenolic resins, fusable phenolic resins and petroleum hydrocarbon resins. The modifying resins usually comprise up to about 45% by wt. of the adhesive. Most of the remainder of a hot melt adhesive is usually comprised of a polyolefin, paraffin or petroleum wax e.g. microcrystalline petroleum wax.

Other hot melt adhesives are based on polyethylene homopolymers and polyamides. These hot melt adhesives tend to be used without tackifiers, waxes and the like.

Polyamide-based hot melt adhesives tend to be expensive, whereas polyethylene and ethylene/vinyl acetate based hot melt adhesives tend to be based on high melt index polymers and limited to porous easy-to-bond substrates.

5 A method for preparing tufted pile carpet using hot melt adhesive is disclosed by Robert A. Reith in U.S. Patent 4,844,765, issued July 4, 1989. The preferred method uses a sheet of hot melt adhesive in the form of a layer of a primary adhesive bonded to a layer of a secondary adhesive, the secondary adhesive being for example the same as the primary adhesive but containing filler.

10 A method has now been found for the manufacture of tufted pile carpet that need not use either latex or hot melt adhesives.

Accordingly, the present invention provides a method for the manufacture of a tufted pile carpet comprising:

- 20 (a) contacting a polyolefin composition of at least one grafted polymer selected from polyolefin, olefin copolymer and olefin terpolymer with a tufted primary carpet backing, said tufted primary carpet backing being comprised of fibres selected from at least one of
- 25 polyamide fibres, polyester fibres, polypropylene fibres, acrylic fibres, rayon fibres and natural fibres and said grafted polymer being selected from at least one of homopolymers of ethylene and propylene, copolymers of ethylene and propylene, terpolymers of ethylene, propylene and diene and copolymers of ethylene with at
- 30 least one of a C_3 - C_{10} hydrocarbon alpha-olefin, vinyl acetate, alkyl acrylate or alkyl methacrylate that has been grafted with at least one monomer selected from ethylenically unsaturated dicarboxylic acids and
- 35 anhydrides thereof, and derivatives thereof;

(b) heating the polyolefin composition to a temperature above the melting point of the polyolefin composition;

5 (c) maintaining the polyolefin composition in contact with the tufted primary carpet backing, at a temperature above the melting point of the polyolefin composition under a pressure and for a period of time sufficient to cause the polyolefin composition to flow around the fibres of the tufted carpet backing;

10 (d) maintaining the polyolefin composition in contact with the tufted primary carpet backing and at a temperature above the melting point of the polyolefin composition for a further period of a least 30 seconds; and

15 (e) cooling the tufted carpet backing and polyolefin composition below the melting point of the composition.

In a preferred embodiment of the method of the present invention, the period of time in step (c) is at least one second.

20 In another embodiment, the period of time in step (d) is at least one minute.

The present invention further provides a method for the manufacture of a tufted pile carpet comprising:

25 (a) placing a polyolefin composition of at least one grafted polymer selected from polyolefin, olefin copolymer and olefin terpolymer, between a tufted primary carpet backing and a secondary carpet backing, said tufted primary carpet backing being comprised of fibres selected from at least one of polyamide fibres, polyester
30 fibres, polypropylene fibres, acrylic fibres, rayon fibres and natural fibres and contacting the polyolefin composition, the grafted polymer being selected from at least one of homopolymers of ethylene and propylene, copolymers of ethylene and propylene, terpolymers of
35 ethylene, propylene and diene and copolymers of ethylene with at least one of a C₃-C₁₀ hydrocarbon alpha-olefin,

vinyl acetate, alkyl acrylate or alkyl methacrylate that has been grafted with a monomer selected from ethylenically unsaturated dicarboxylic acids and anhydrides thereof, and derivatives thereof;

5 (b) heating the polyolefin composition to a temperature above the melting point of the polyolefin composition;

(c) maintaining the polyolefin composition in contact with the tufted primary carpet backing, at a temperature above the melting point of the polyolefin composition under a pressure and for a period of time sufficient to cause the polyolefin composition to flow around the fibres of the tufted carpet backing;

10 (d) maintaining the polyolefin composition in contact with the tufted primary carpet backing and at a temperature above the melting point of the polyolefin composition for a further period of a least one minute; and

(e) cooling said carpet backings and polyolefin composition below the melting point of the composition.

20 In a preferred embodiment of the method of the present invention, the period of time in step (c) is at least one second.

In another embodiment, the polyolefin composition is a blend of at least one grafted polymer with at least one of un-grafted polymer and fillers.

25 In a further embodiment, the polyolefin composition is used in the form of a multilayered structure having the polyolefin composition on one face and a very low density polyethylene (VLDPE) or filled ethylene/vinyl acetate copolymer on the opposing face.

30 In yet another embodiment, the secondary carpet backing is selected from jute, woven tapes of polypropylene, non-woven synthetic polymer fabrics, e.g. Typar® spun-bonded polypropylene and spun-bonded polyethylene terephthalate, plain woven polypropylene fabrics, felts including felts of shredded used carpets,

thermoplastic polymer films and oriented thermoplastic polymer films, and combinations thereof, including leno woven structures, and other related structures.

The present invention also provides tufted pile
5 carpet comprising:

a tufted primary carpet backing stabilized with a polyolefin composition of at least one grafted polymer selected from polyolefin, olefin copolymer and olefin
10 terpolymer, said tufted primary carpet backing being comprised of fibres selected from at least one of polyamide fibres, polyester fibres, polypropylene fibres, acrylic fibres, rayon fibres and natural fibres and said grafted polymer being selected from at least one of
15 homopolymers of ethylene and propylene, copolymers of ethylene and propylene, terpolymers of ethylene, propylene and diene and copolymers of ethylene with at least one of a C_3 - C_{10} hydrocarbon alpha-olefin, vinyl acetate, alkyl acrylate or alkyl methacrylate that has
20 been grafted with a monomer selected from ethylenically unsaturated dicarboxylic acids and anhydrides thereof, and derivatives thereof.

The present invention further provides a tufted pile carpet comprising:

a polyolefin composition located between and bonded
25 to a tufted primary carpet backing and a secondary carpet backing, said tufted primary carpet backing being comprised of fibres selected from at least one of polyamide fibres, polyester fibres, polypropylene fibres, acrylic fibres, rayon fibres and natural fibres and the
30 polyolefin composition being at least one grafted polymer selected from polyolefin, ethylene copolymer and ethylene terpolymer, the polymer being at least one of homopolymers of ethylene and propylene, copolymers of
ethylene and propylene, terpolymers of ethylene,
35 propylene and diene and copolymers of ethylene with at least one of a C_3 - C_{10} hydrocarbon alpha-olefin, vinyl acetate, alkyl acrylate or alkyl methacrylate that has

been grafted with a monomer selected from ethylenically unsaturated dicarboxylic acids and anhydrides thereof, and derivatives thereof.

5 In another embodiment, the polyolefin composition is a blend of at least one grafted polymer with at least one of fillers and un-grafted polymers.

10 In a further embodiment, the polyolefin composition is a multilayered structure having polyolefin composition on one face and a very low density polyethylene (VLDPE) or filled ethylene/vinyl acetate copolymer on the opposing face.

15 The present invention relates to a method for the manufacture of a tufted pile carpet. In the method, tufted primary carpet backing is contacted with polyolefin composition at a temperature above the melting point of the polyolefin composition. The polyolefin composition is maintained in contact with the tufted primary carpet backing for a period of time sufficient to cause the polyolefin composition to flow around the 20 fibres of the tufted carpet backing and then for a further additional period of time of at least 30 seconds. Subsequently, or simultaneously, a secondary carpet backing may be applied.

25 The primary carpet backing is in the form of a backing with tufted fibres. The backing may be a woven material formed from natural or synthetic materials, examples of which are jute, wool, rayon, polyamides, polyesters and polyolefins. Nonwoven backings may also be used. In preferred embodiments, the primary backing 30 is a fabric woven from tapes and/or yarns and is in the form a flat material with substantially uniform thickness.

The primary backing is tufted, usually using a needle punching procedure, to provide a tufted carpet 35 backing having tufts of fibre extending from one surface; this surface is usually called the face surface. The yarns used in the tufting procedure may be at least one

of polyamide, polyesters, polyolefins, acrylic polymers or other natural or synthetic materials, as is known in the art. Polyamide yarns are preferred. The tufts may be in the form of loops or loops that have been slit, and the yarns may be twisted or bulked or in other forms, all of which is known in the art. The density of the tufts, the size of the tufts and the height of the tufts may all be varied, depending on the carpet quality and style to be made.

10 The polyolefin composition is contacted with the tufted primary carpet backing. The polyolefin composition may be in the form of sheet which may be laid onto the carpet backing or the polyolefin composition may be extrusion coated in molten form directly onto the primary carpet backing. The latter method may be of particular interest in instances in which the carpet does not have a secondary carpet backing e.g. automotive end-uses. When the carpet has a secondary carpet backing, the polyolefin composition may be contacted with the primary carpet backing directly, but it is preferred that 20 the polyolefin composition be applied to the secondary carpet backing, preferably by extrusion coating, and then contacted with the primary carpet backing.

The polyolefin composition may be formed from at least one of a homopolymer of ethylene, a homopolymer of propylene, copolymers of ethylene and propylene especially copolymers of propylene with minor amounts of ethylene as in impact and random copolymer polypropylene, terpolymers of ethylene, propylene and dienes e.g. so-called EPDM, or a copolymer of ethylene with at least 30 one of a C_3 - C_{10} hydrocarbon alpha-olefin, vinyl acetate, alkyl acrylate or alkyl methacrylate. Examples of the hydrocarbon alpha-olefins include butene-1, hexene-1 and octene-1. Examples of the alkyl groups of the (meth)acrylates include methyl, ethyl, propyl and butyl. 35 The copolymers may include both linear low density

polyethylene (LLDPE) and very low density polyethylene (VLDPE).

The grafting monomer is at least one monomer selected from ethylenically unsaturated carboxylic acids and ethylenically unsaturated carboxylic acid anhydrides, including, less preferably, derivatives of such acids, and mixtures thereof. Examples of the acids and anhydrides, which may be mono-, di- or polycarboxylic acids, are acrylic acid, methacrylic acid, maleic acid, fumaric acid, itaconic acid, crotonic acid, itaconic anhydride, maleic anhydride, and substituted maleic anhydride, e.g. dimethyl maleic anhydride or citraconic anhydride, nadic anhydride, nadic methyl anhydride, and tetrahydrophthalic anhydride, maleic anhydride being particularly preferred. Examples of the derivatives of the unsaturated acids are salts, amides, imides and esters e.g. mono- and disodium maleate, acrylamide, maleimide, glycidyl methacrylate and dimethyl fumarate. Techniques for the grafting of such monomers onto the polyolefin are known e.g. as described in U.S. Patent 4 612 155 of R.A. Zelonka and C.S. Wong, which issued September 16, 1986, and in published European patent application No. 0 369 604 of D.J. Mitchell, published May 23, 1990. The present invention will be particularly described herein with reference to maleic anhydride as the grafting monomer.

If the grafted polymer is used as is i.e. not in the form of a blend with another polymer, then the maleic anhydride content of the grafted polymer should be greater than about 0.03% by weight, and preferably in the range of about 0.08-0.12% by weight, e.g. about 0.1% by weight. Maleic anhydride contents of less than 0.03% by weight may be usable provided that long contact times of the melted grafted polymer and the fibres of the carpet are used. Preferably, the melt index of the grafted polymer composition should be less than about 500 dg/min, and preferably less than 200 dg/min, as measured by the

procedure of ASTM D-1238 (Condition E). It is preferred that the melt index be at least 5 dg/min, especially at least 10 dg/min and particularly in the range of 10-200 dg/min. It is understood that the melt index is measured on the composition as applied to the carpet backing, not the grafted polymer per se, although these could be the same.

It may be desirable, and in some instances particularly preferred, that the grafted polymer be blended with another polymer, the other polymer being a polymer compatible with the grafted polymer. For instance, it is common practice in the preparation of grafted polyolefin compositions to blend grafted polymer with un-grafted polymer, often the same polymer as has been grafted. Grafted polypropylene homopolymers and grafted impact polypropylene copolymers are not normally suitable in an un-blended condition because the melting point is so high that distortion of polypropylene homopolymer primary or secondary carpet backings tends to occur on contact with the molten graft polymer, either on extrusion coating or especially on lamination e.g. lamination of primary and secondary carpet backings in an oven, as described herein. If the ethylene content of random copolymer polypropylene is greater than about 2.9%, and especially greater than about 3.9%, then such polymers tend to have a sufficiently low melting point to overcome such a heat distortion problem. Similarly, grafted polyethylenes with high melting points may not be suitable because of distortion of the carpet backing and/or inferior adhesion to polypropylene carpet backing.

In preferred embodiments, the polyolefin composition is a blend of maleic-anhydride grafted polyethylene, the polyethylene being LDPE, VLDPE, LLDPE or HDPE. The blends are formed with VLDPE, VLDPE and LLDPE, LDPE especially those with melting points above 98°C, blends of LDPE and VLDPE and blends of LDPE, VLDPE and LLDPE.

In particular, the VLDPE has a density of less than 0.910 and especially less than 0.895 g/cm³.

When the grafted polymers are blended, the concentration of the grafted monomer in the blend should still be greater than about 0.03-0.3% by weight given above and the melt index should be less than 500 dg/min, as also stated above. However, the considerations of melting point of the blend with respect to heat distortion of the secondary carpet backing still need to be considered. Thus, with polypropylene carpet backings, blends with homopolymer polypropylene, impact copolymers and random copolymers having less than 2.9% ethylene should not be used.

A further consideration is that the grafted polymer and ungrafted polymer should be compatible. Generally, a grafted polymer may be blended with a related ungrafted polymer. However, for example, the blending of a grafted ethylene/vinyl acetate copolymer having a low vinyl acetate content with an ungrafted ethylene/vinyl acetate copolymer having a high vinyl acetate content may not be satisfactory. The grafted polymer may be blended with certain unrelated ungrafted polymers e.g. a grafted ethylene/propylene/diene (EPDM) copolymer may be blended with an ethylene/vinyl acetate copolymer.

If it is desired to increase the ease with which the carpet when discarded can be recycled into useful product by remelting the carpet, it may be desirable to select an adhesive composition i.e. grafted polyolefin, which is compatible with the carpet. Thus adhesives based on ethylene/alkyl acrylate copolymers and polypropylene would be preferred. Adhesives based on ethylene/vinyl acetate copolymer are less preferred as they tend to decompose at the melting point of polyamides e.g. nylon 66.

In making adhesive compositions from unblended or blended grafted polymers, an elastomer which is not miscible with the grafted polymer or any ungrafted

polymer may be added, especially in amounts of 10-30% by weight.

The melting point of the polyolefin composition used in the process of the invention needs to be at least 50°C. However, the melting point could have an effect on the dimensional stability of the carpet that is obtained and higher melting points are preferred, especially above 70°C. Nonetheless, compositions with low melting points are advantageous in the manufacturing process as this results in the compositions requiring less heat in order to become soft and/or melt and flow into the tufts. Thus, lower melting points result in the use of lower temperatures in the process or the ability to operate the process at higher operating speeds. The polyolefin composition compositions should melt at temperatures below the temperature at which distortion of the carpet backings may occur during the process for the manufacture of carpet. For instance, if the carpet backing is polypropylene homopolymer, then the melting point of the composition should be below about 140°C.

In use, the polyolefin composition is heated to a temperature above the melting point of the polymer. If the polyolefin composition is in the form of a sheet, this may be done by heating the combination of tufted backing and sheet of polyolefin composition in an oven, which is preferred, or by passing the combination around heated rollers. If the polyolefin composition is applied to the primary carpet backing as an extrusion coating, the polyolefin composition will already be at a temperature above its melting point. When the carpet has a secondary carpet backing, combinations of primary and secondary carpet backings with interposed sheet of polyolefin composition or more commonly combinations of primary carpet backing with secondary carpet backing that is already coated with polyolefin composition may be treated in an oven, which is preferred, or by heated rollers.

The polyolefin composition is maintained in contact with the tufted primary carpet backing at the temperature above the melting point of the polyolefin composition for a period of time sufficient to cause the polyolefin composition to flow around the fibres of the tufted carpet backing. This period of time will depend in particular on the melt flow characteristics of the polyolefin composition. It is to be understood that the polyolefin composition should penetrate each bundle of fibres in the tufted carpet backing, but that normally the polyolefin composition will not encapsulate each and every fibre of the bundle. A pressure is applied to the combination of tufted primary carpet backing and polyolefin composition to cause the polyolefin composition to flow around the fibres. This period of time should be at least 0.5 seconds and preferably 1-10 seconds. In particular, a period of 1-2 seconds is used, but this preferred period of time will depend on the melt flow characteristics of the particular polyolefin composition being used, as well as the pressure that is applied. While the polyolefin composition may be applied to the primary carpet backing in the absence of a secondary carpet backing, it is preferred that the polyolefin composition be applied to the primary carpet backing in the presence of a secondary carpet backing, and particularly preferred to apply the polyolefin composition to the secondary carpet backing prior to contacting the polyolefin composition with the primary carpet backing.

Subsequently the polyolefin composition is maintained in contact with the tufted primary carpet backing at the temperature above the melting point of the polyolefin composition for a further period of at least 30 seconds. In preferred embodiments, this period of time is at least 1 min. and especially in the range 1-2 mins. Bonding may occur between the polyolefin composition and

the tufted carpet fibres, especially polyamide fibres, during this period of time.

5 The tufted carpet backing, which is usually in the form of primary and secondary carpet backings bonded together with polyolefin composition, is normally then cooled. However, if the tufted carpet backing is in the form of a primary carpet backing bonded to the polyolefin composition, then it could be fed directly into a laminating operation with a secondary carpet backing.

10 It will be noted that the process of the invention does not include a step in which a latex or a hot-melt adhesive is applied.

In an embodiment of the process of the invention, the polyolefin composition is in the form of a multi-layered structure having polyolefin composition on one face i.e. the face that will contact the primary carpet backing, and another material on the other face. The other material is a material that will bond to a secondary carpet backing. Examples include
20 ethylene/vinyl copolymers and very low density polyethylene (VLDPE), which may be unfilled polymers but in preferred embodiments are filled polymers. Examples of suitable fillers include calcium carbonate and barium sulphate. The polyolefin composition would be used in
25 the form of a multilayered structure in order to provide stiffness or sound deadening properties to the carpet and/or to reduce the cost of the layer, polyolefin composition normally being more expensive than filled ethylene/vinyl acetate polymers or very low density
30 polyethylene.

A secondary carpet backing may be applied to the combination of tufted primary carpet backing and polyolefin composition. Examples of secondary carpet backing include jute, woven tapes of polypropylene, plain
35 woven polypropylene fabrics, felts including felts of shredded used carpet, thermoplastic polymer films and oriented thermoplastic polymer films. The polyolefin

composition will bond directly to such secondary carpet backing. If the polyolefin composition is in the form of a multi-layered structure, then the material other than the polyolefin composition needs to be such that the material will bond to the secondary carpet backing. As an alternative, an adhesive may be applied to the secondary carpet backing to promote adhesion with the polyolefin composition or multi-layered structure.

While the carpet may be comprised of primary carpet backing and polyolefin composition, the carpet will more commonly be comprised of primary carpet backing, polyolefin composition and secondary carpet backing. Both the primary carpet backing and the secondary carpet backing may be bonded to the polyolefin composition. Alternatively, the primary carpet backing may be bonded to the polyolefin, but an intermediate layer of, for example, a filled polymer, may be located between the polyolefin composition and the secondary carpet backing. The tufted fibres will normally be dyed, as a single colour throughout the carpet or in a pattern of differing colours. The secondary carpet backing and the polyolefin composition will normally not be dyed, but may be if it is important that the underlying layers be of a suitable masking shade compatible with the colours of the fibres. The materials and structure of the carpet backings and the polyolefin composition have been described above.

Conventional drying and curing ovens used in latex lamination processes may be used in the process of the present invention. A process using conventional latex ovens is disclosed by Ryan in U.S. 3,734,800.

The present invention is illustrated by the following examples. The adhesive resin compositions of the types used in the examples i.e. polyolefin composition, generally be described as being polyolefin thermoplastic polymers which have been chemically modified by grafting with maleic anhydride (MAN), maleic acid (MA) or acrylic acid (AA) onto the backbone of the

polymer. In a typical example, the amount of grafted maleic anhydride used is 1 wt%. The polymer that was grafted was one of the following: ethylene/methyl acrylate (EMA), ethylene vinyl acetate (EVA), linear low density polyethylene (LLDPE), low density polyethylene (LDPE), high density polyethylene (HDPE) and random copolymer polypropylene (coPP).

Example I

The grafted polymer was compounded or dry-blended with additional amounts of ungrafted base polymer in a 10/90 ratio, which gives a final wt% of grafted maleic anhydride of 0.1%. The resultant adhesive resin composition was then either extruded into a film or extrusion coated over a carpet secondary backing. The secondary backing was, unless specified to the contrary, a Leno woven polypropylene identified as ACTIONBAC® and manufactured by Patchogue Plymouth, a division of AMOCO Fabrics and Fibres.

The tufted primary carpet backing used in these examples was prepared in the following manner: Bulk continuous filament (BCF) nylon 6,6 yarn of 1410 total denier and composed of 72 filaments (trilobal cross-section) was produced by a conventional process. Two of these yarns were plied and twisted to provide a yarn having a balanced twist of 3.5 turns per inch (tpi). The resultant yarn was then conventionally heat-set in a "SUPERBA" heat-set apparatus at 270 F (132°C). A cut-pile tufted carpet was constructed from the heat-set yarn using "POLYBAC", a woven polypropylene primary backing, available from Patchogue Plymouth (a division of AMOCO). The carpet was constructed of the following specifications: 40 oz/yd², 0.75" pile height, 1/8 gauge and a stitch density of 8 x 10 per square inch. Both dyed (dark blue) and greige samples were used in the following examples. BCF nylon 6,6 yarn was also used in the same manner to produce commercial (loop pile) carpet samples with 10 x 10 stitch density.

The tufted primary carpet sample was then brought into contact with the secondary carpet backing or a layer of the film, and the resultant structure was laminated to form a carpet sample.

5 The samples were laminated using an electrically heated press. The samples were placed on the platens of the heating press for a period of 3-3.5 minutes until the sample had reached a set temperature (100-145°C). The platens of the press were then closed and the samples
10 were left under pressure (7-138 kPa) for a period of time (1 sec - 3 minutes). The samples were then either removed or kept for 1 second - 5 minutes at elevated temperatures before being cooled down to room temperature and conditioned according to the procedure of ASTM D1776
15 for at least 24 hours prior to testing.

The samples were tested according to the following procedures:

Tuft pull out, by the procedure of ASTM D1335 using at least two samples and a minimum of 5 tufts per sample;

20 Secondary delamination, by the procedure of ASTM D3936 using an Instron® apparatus on samples that had a width of 5 cm; and

Tufted encapsulation, by visual inspection of the number of filaments encapsulated.

25 In Runs 1-12, a VLDPE with a density of 0.895 g/cm³ and a melt index of 12 dg/min (CLEARFLEX™ Grade MW 1980 obtained from Enimont) was used in an amount of 50-100 wt%. The polymer was compounded or dry-blended with high density polyethylene that had been grafted with maleic
30 anhydride (Fusabond® 100D manufactured by DuPont Canada Inc.) (0-30%) and a linear low density polyethylene (LLDPE, Sclair® 2316, an ethylene/butene-1 copolymer with density of 0.93 g/cm³ and a melt index of 75 dg/min, available from NOVA Corporation of Calgary, Alberta) in
35 amounts of 0-40%. The resultant compositions had a melt flow index (ASTM procedure D-1238, Condition E) of 8-70 dg/min.

The compositions were as follows:

Table I

	Run	Keldax* (wt %)	VLDPE (wt %)	LDPE LLDLPE (wt %)	Grafted Polymer	MI (g/10 min.)	Grafted MAN (wt %)**
5	1		100	0	0	11.5	0
	2		95	0	05	10.7	0.05
	3		90	0	10	9.7	0.1
	4		85	0	15	9.3	0.15
10	5		80	0	20	8.2	0.20
	6		90	0	10	9.7	0.1
	7		90	0	10	9.7	0.1
	8					3	
15	1st Layer	100			10	9.7	0.1
	2nd Layer		90		10	21	0.1
	9		55	35	10	21	0.1
	10		55	35	10	4.1	0.1
	11		0	90	10	4.1	0.1
20	12		0	90	10		

* Keldax® 6868 filled polymer, an ethylene/vinyl acetate copolymer filled with calcium carbonate (60-70% by wt)

** maleic anhydride, weight %

25 The compositions of Runs 1-5 of Table I were extruded into film having a thickness of 0.25 mm. The films were placed between a dyed residential pre-tufted primary carpet backing and a polypropylene secondary carpet backing. The samples were then placed in an electrical press and laminated for a period of 2-2.5 minutes.

30 Further details and the results obtained are given in Table II. In each instance, the pressure used was 31 kPa.

Table II

Run	Film Thickness	Temp. (C)	Dwell Time (sec)	Res. (N)	Tuft-Bind Comm. (N)	Tuft-Bind	Encapsulation
5							
1	0.25	135	150	10.7		poor	
2	0.25	135	150	15.0		poor	
3	0.25	135	150	19.5		fair	
4	0.25	135	150	18.7		fair	
5	0.25	135	150	16.5		fair	
10	0.25	145	*	14.3		poor	
6	0.25	135	*	30.0		v. good	
7	0.5	135	*	*	23.3		fair
8	0.28 + 0.15	145	*	16.1		good	
9	0.25	145	*	29.6		v. good	
15	0.35	140	*	13.0		poor	
10	0.25	135	150		45.7		
11	0.25	135	150				
12	0.25	135	150				

* preheating sample to set temperature, exerting pressure for 2 sec. followed by one minute of postheating

Tuft-Bind Res. = Tuft bind for residential (cut pile) carpet
 Tuft-Bind Comm. = Tuft bind for commercial (loop pile) carpet

As used herein, residential carpet refers to a carpet in which the loops of the tufts have been slit i.e. each tuft is independent of the adjacent tuft, whereas commercial carpet refers to a looped carpet, specifically a so-called level loop carpet, in which the fibres form part of more than one tuft. Thus, as a consequence of the construction of the two types of carpets, results for commercial carpets would be expected to be higher than for residential carpets e.g. by a factor of at least two.

In Tables I and II, Run No. 1 is a control run. The minimum requirement for tuft-bind of 13.4N for residential carpet was achieved in Runs 1-5 except control Run 1; among these, the best result was obtained in Run 3 which used 10% graft polymer and 90% VLDPE.

Runs 6-10 represent a simulation of a continuous bonding process which involved preheating the sample to a predetermined temperature followed by exerting a pressure of 31 kPa for only 2 seconds and finally allowing for a further minute of bonding at the predetermined temperature. As indicated by the results for Run 6, the tuft-bind dropped to 14.3N (compared to Run 3); it is presumed that this is due to insufficient time for the adhesive to reach all of the filaments in the carpet

tufts. Increasing the film thickness to 0.5 mm (20 mil, however, more than doubled the tuft-bind to 30.0N (Run 7), thereby indicating that film thickness is an important factor in the results obtained. The tuft encapsulation improved significantly with increasing film thickness.

Use of thick films increases the cost of the carpet structure. An alternative to a thick film is to use an inexpensive, unfunctionalized mostly filled polymer with a low melt flow as one layer of the film viz. the layer opposed that binding to the fibres. An example is Keldax® ethylene vinyl acetate filled with calcium carbonate (70-80% loading). Run 8 shows the results of using a two layer structure of 11 mil layer of Keldax® filled composition and 6 mil of VLDPE based adhesive. Tuft-bind was as high as 23.3N was obtained.

Another way to improve the tuft-bind is to add high flow linear low density polyethylene (LLDPE) to the formulation in amounts up to 40 wt%, as shown by Run 9. The tuft-bind increased up to 16.1N, compared to 14.8N in the absence of LLDPE, and encapsulation improved substantially. Further improvement of tuft-bind and encapsulation may be obtained using a polypropylene woven scrim coated with about 0.35 mm (14 mil) of the composition (Run 10). Using the "short cycle" to laminate the structure, average tuft-bind of 29.6N and excellent encapsulation (91.1 %) was achieved.

Run 11 shows the use of low density polyethylene (LDPE, density of 0.918 g/cm³ and a melt index of 7 dg/min from AT Plastics (grade AT 472) blended with grafted polyethylene. The residential carpet sample made with this composition had a tuft-bind of only 13.0N for a 0.25 mm (10 mil) film. However, when this composition was laminated to a contract carpet, a tufted bind as high as 45.7 N was obtained. This indicates that some selection of the coatings and the secondary carpet backing may be required in order to obtain optimum results.

Example II

The procedure of Example I was repeated using a sample of copolymer polypropylene viz. a random copolymer polypropylene obtained from Fina with a 6% ethylene content and a melting point of 129°C. The copolymer was grafted with maleic anhydride and then compounded with ungrafted copolymer at a ratio of 10/90. The resultant composition had a melt index of 3 dg/min. and a maleic anhydride content of 0.1 %.

Further details obtained are given in Table III.

Table III

Run	coPP	g-coPP*	MI**	MAN%
13	90	10	3	0.1
14	90	10	3	0.1

* grafted copolymer polypropylene
 ** measured at 230°C

The sample obtained, at 140°C using a pressure of 31 kPa and a dwell time of 150 seconds, had adequate tuft-bind (19.2N) for both residential and commercial carpet samples. However, the encapsulation obtained was poor, due it is believed to the low melt flow properties of the composition.

Example III

Ethylene/methyl acrylate (EMA) copolymers obtained from Exxon as Optema Grades T-113, T-120, T-130, T-140 and XS93.04 having methyl acrylate content of 21-28 % by wt, were melt compounded with ethylene/methyl acrylate grafted with maleic anhydride (Fusabond © 160D from DuPont Canada Inc.). The ratios of two polymers used varied from 100/0 to 70/30 wt%.

The resulting compositions were extruded into films having a thickness of 0.25 mm (10 mil) and subsequently laminated with the pre-tufted primary carpet backing of Example I. The lamination procedure used involved a vacuum box. The carpet structure was placed over a perforated flat surface with the fibres of the primary carpet facing backwards and a dead weight on top of the secondary carpet backing. The whole structure was placed

inside an oven at a predetermined temperature of 160°C. After the temperature had stabilized, vacuum was applied through the perforated surface for 30 seconds. The sample was then removed and cooled down to room temperature and conditioned for testing.

Table IV indicates the compositions of the samples of Runs 16-19 and Table V summarizes the results that were obtained.

Table IV

Run	EMA	Fusabond 160D (wt %)	MI (g/10 min.)	Grafted MAn (wt%)
15	TC113 (90%) 10%	1	0.1	
16	TC123 (90%) 10%	6	0.1	
17	TC130 (90%) 10%	20	0.1	
18	TC140 (90%) 10%	135	0.1	0.1
19	XS 93.04 (90%)	10%	270	

Table V

	Run	Film Thickness	Dwell Time	Tuft-Bind (N)	Delamination*	
	Encapsulation	(mm)	(s)	(N/cm)		
20						
	15	0.25	480	5.4	3.5	poor
	16	0.25	480	8.1	5.8	poor
	17	0.25	480	8.1	18.3	fair
	18	0.25	480	16.1	41.1	v.good
	19	0.25	480	15.2	22.2	v.good
30						

* the minimum requirement for delamination is 4.4 N/cm of carpet backing.

As can be seen, the highest results were obtained when the melt index was around 135 dg/min; the delamination results were as high as 41.1 N/cm, about 10 times higher than the minimum requirement. In some instances, the bonds formed were so strong that the testing procedure destroyed the sample.

Example IV

The procedure of Example III was repeated, using ethylene/vinyl acetate copolymer obtained from E.I. du Pont de Nemours and Company as Elvax® grades 220 and 240, both having a vinyl acetate content of 28%. These copolymers were melt compounded with a maleic anhydride grafted ethylene/vinyl acetate copolymer (Fusabond® 190D). The grafted polymer composition was formed into a two-layer structure with the other layer being Keldax®

filled polymer; the grafted polymer film was placed adjacent to the primary carpet backing and the Keldax® filled polymer film was placed adjacent to the secondary carpet backing. The resultant structure was bonded using an electrically heated press at temperatures as low as 100°C.

Further details on the compositions and the results obtained are given in Table VI and VII. The pressure used (Table VI) was 31.0 kPa.

Table VI

Run	Keldax*	EVA (%)	Fusabond 190D (%)	MI (g/10 min.)	Grafted MAn (wt%)**
20	1st Layer 100 2nd Layer 87.5	12.5		3.1 43	0.1%
21	1st Layer 100 2nd Layer 87.5	12.5		3.1 43	0.1%

* Keldax® 6868 filled polymer, an ethylene/vinyl acetate copolymer filled with calcium carbonate (60-70% by wt)
 ** maleic anhydride, weight %.

Table VII

Run	Film Thickness (mm)	Temperature (°C)	Dwell Time	Tuft-Bind (N) (residential)	Tuft-Bind (N) (commercial)
20	0.25 ± 0.175	135	*	19.7	29.1
21	0.25 ± 0.175	135	*		

* preheating sample to set temperature, exerting pressure for 2 sec. followed by one minute of postheating

As may be observed from the results obtained, both residential and commercial samples pass the minimum requirement for tuft-bind. The encapsulation in Run 20 was fair.

CLAIMS:

1. A method for the manufacture of a tufted pile carpet comprising:

- 5 (a) contacting a polyolefin composition of at least one grafted polymer selected from polyolefin, olefin copolymer and olefin terpolymer with a tufted primary carpet backing, said tufted primary carpet backing being comprised of fibres selected from at least one of polyamide fibres, polyester fibres, polypropylene fibres,
10 acrylic fibres, rayon fibres and natural fibres and said grafted polymer being selected from at least one of homopolymers of ethylene and propylene, copolymers of ethylene and propylene, terpolymers of ethylene, propylene and diene and copolymers of ethylene with at
15 least one of a C_3 - C_{10} hydrocarbon alpha-olefin, vinyl acetate, alkyl acrylate or alkyl methacrylate that has been grafted with at least one monomer selected from ethylenically unsaturated dicarboxylic acids and anhydrides thereof, and derivatives thereof;
- 20 (b) heating the polyolefin composition to a temperature above the melting point of the polyolefin composition;
- (c) maintaining the polyolefin composition in contact with the tufted primary carpet backing, at a
25 temperature above the melting point of the polyolefin composition under a pressure and for a period of time sufficient to cause the polyolefin composition to flow around the fibres of the tufted carpet backing;
- (d) maintaining the polyolefin composition in
30 contact with the tufted primary carpet backing and at a temperature above the melting point of the polyolefin composition for a further period of at least 30 seconds; and
- (e) cooling the tufted carpet backing and
35 polyolefin composition below the melting point of the composition.

2. The method of Claim 1 in which the period of time in step (c) is at least one second.

3. The method of Claim 1 or Claim 2 in which the period of time in step (d) is at least one minute.

5 4. The method of any one of Claims 1-3 in which the polyolefin composition has a melting point in the range from 50°C to below the heat distortion temperature of the carpet backing.

10 5. A method for the manufacture of a tufted pile carpet comprising:

15 (a) placing a polyolefin composition of at least one grafted polymer selected from polyolefin, olefin copolymer and olefin terpolymer, between a tufted primary carpet backing and a secondary carpet backing, said tufted primary carpet backing being comprised of fibres selected from at least one of polyamide fibres, polyester fibres, polypropylene fibres, acrylic fibres, rayon fibres and natural fibres and contacting the polyolefin composition, the grafted polymer being selected from at least one of homopolymers of ethylene and propylene, copolymers of ethylene and propylene, terpolymers of ethylene, propylene and diene and copolymers of ethylene with at least one of a C₃-C₁₀ hydrocarbon alpha-olefin, vinyl acetate, alkyl acrylate or alkyl methacrylate that
20 has been grafted with a monomer selected from
25 ethylenically unsaturated dicarboxylic acids and anhydrides thereof, and derivatives thereof;

30 (b) heating the polyolefin composition to a temperature above the melting point of the polyolefin composition;

(c) maintaining the polyolefin composition in contact with the tufted primary carpet backing, at a temperature above the melting point of the polyolefin composition under a pressure and for a period of time
35 sufficient to cause the polyolefin composition to flow around the fibres of the tufted carpet backing;

(d) maintaining the polyolefin composition in contact with the tufted primary carpet backing and at a temperature above the melting point of the polyolefin composition for a further period of a least one minute;
5 and

(e) cooling said carpet backings and polyolefin composition below the melting point of the composition.

6. The method of Claim 5 in which the period of time in step (c) is at least one second.

10 7. The method of Claim 5 or Claim 6 in which the the polyolefin composition is a blend of at least one grafted polymer with at least one of un-grafted polymer and fillers.

15 8. The method of any one of Claims 5-7 in which the polyolefin composition is used in the form of a multilayered structure having polyolefin composition on one face and a very low density polyethylene (VLDPE) or filled ethylene/vinyl acetate copolymer on the opposing face.

20 9. The method of any one of Claims 5-8 in which the secondary carpet backing is selected from jute, woven tapes of polypropylene, non-woven synthetic polymer fabrics, plain woven polypropylene fabrics, felts including felts of shredded used carpets, thermoplastic
25 polymer films and oriented thermoplastic polymer films, and combinations thereof, leno woven structures and other related structures.

10. The method of any one of Claims 1-9 in which the grafting monomer is maleic anhydride.

30 11. The method of any one of Claims 1-10 in which the polyolefin composition contains at least 0.03% by weight of grafted monomer.

35 12. The method of any one of Claims 1-10 in which the polyolefin composition contains 0.08-0.10% by weight of grafted monomer.

13. The method of any one of Claims 1-12 in which the polyolefin composition has a melt index of less than 500 dg/min.

5 14. The method of any one of Claims 1-12 in which the polyolefin composition has a melt index of less than 200 dg/min.

15 15. The method of any one of Claims 1-14 in which the polyolefin composition has a melting point in the range from 75°C to below the heat distortion temperature
10 of the carpet backing.

16. The method of any one of Claims 1-15 in which, in step (a), the polyolefin composition has been extrusion coated onto secondary carpet backing and then contacted with the primary carpet backing.

15 17. The method of any one of Claims 1-15 in which polyolefin composition is applied by extrusion coating.

18. The method of Claim 17 in which the polyolefin composition is extrusion coated onto the primary carpet backing.

20 19. The method of any one of Claims 1-18 in which the fibres are polyamide fibres.

20. The method of Claim 19 in which the polyamide fibres are nylon 66 fibres.

25 21. The method of any one of Claims 1-20 in which the fibres are polyamide fibres, the carpet backing is formed from polypropylene and the grafting monomer is maleic anhydride.

22. A tufted pile carpet comprising:
a tufted primary carpet backing stabilized with a
30 polyolefin composition of at least one grafted polymer selected from polyolefin, olefin copolymer and olefin terpolymer, said tufted primary carpet backing being comprised of fibres selected from at least one of
polyamide fibres, polyester fibres, polypropylene fibres,
35 acrylic fibres, rayon fibres and natural fibres and said grafted polymer being selected from at least one of homopolymers of ethylene and propylene, copolymers of

ethylene and propylene, terpolymers of ethylene, propylene and diene and copolymers of ethylene with at least one of a C_3-C_{10} hydrocarbon alpha-olefin, vinyl acetate, alkyl acrylate or alkyl methacrylate that has
 5 been grafted with a monomer selected from ethylenically unsaturated dicarboxylic acids and anhydrides thereof, and derivatives thereof.

23. A tufted pile carpet comprising:
 a polyolefin composition located between and bonded
 10 to a tufted primary carpet backing and a secondary carpet backing, said tufted primary carpet backing being comprised of fibres selected from at least one of polyamide fibres, polyester fibres, polypropylene fibres, acrylic fibres, rayon fibres and natural fibres and the
 15 polyolefin composition being at least one grafted polymer selected from polyolefin, ethylene copolymer and ethylene terpolymer, the polymer being at least one of homopolymers of ethylene and propylene, copolymers of ethylene and propylene, terpolymers of ethylene,
 20 propylene and diene and copolymers of ethylene with at least one of a C_3-C_{10} hydrocarbon alpha-olefin, vinyl acetate, alkyl acrylate or alkyl methacrylate that has been grafted with a monomer selected from ethylenically unsaturated dicarboxylic acids and anhydrides thereof,
 25 and derivatives thereof.

24. The carpet of Claim 22 or Claim 23 in which the polyolefin composition is a blend of at least one grafted polymer with at least one of fillers and un-grafted polymers.

30 25. The carpet of any one of Claims 22-24 in which the polyolefin composition is a multilayered structure having polyolefin composition on one face and a filled ethylene/vinyl acetate copolymer or VLDPE on the opposing face.

35 26. The carpet of any one of Claims 22-25 in which the polyolefin composition has a melting point in the

range from 50°C to below the heat distortion temperature of the carpet backing.

27. The carpet of any one of Claims 22-26 in which the secondary carpet backing is selected from jute, woven tapes of polypropylene, non-woven synthetic polymer fabrics, plain woven polypropylene fabrics, felts including felts of shredded used carpets, thermoplastic polymer films and oriented thermoplastic polymer films, and combinations thereof, leno woven structures and other related structures.

28. The carpet of any one of Claims 22-27 in which the grafting monomer is maleic anhydride.

29. The carpet of any one of Claims 22-28 in which the polyolefin composition contains at least 0.03% by weight of grafted monomer.

30. The carpet of any one of Claims 22-29 in which the polyolefin composition contains 0.08-0.10% by weight of grafted monomer.

31. The carpet of any one of Claims 22-30 in which the polyolefin composition has a melt index of less than 200 dg/min.

32. The carpet of any one of Claims 22-31 in which the polyolefin composition has a melting point in the range from 75°C to below the heat distortion temperature of the carpet backing.

33. The carpet of any one of Claims 22-32 in which the fibres are polyamide fibres.

34. The carpet of Claim 33 in which the polyamide fibres are nylon 66 fibres.

35. The carpet of any one of Claims 22-34 in which the fibres are polyamide fibres, the carpet backing is formed from polypropylene and the grafting monomer is maleic anhydride.

36. Methods for the manufacture of tufted pile carpets substantially as herein described and exemplified.

5 37. Carpets made by a method according to any one of claims 1 to 21 or 37.

38. Tufted pile carpets substantially as herein described and exemplified.

Examiner's report to the Comptroller under Section 17
(The Search report) - 31 -

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Databases (see below)

- (i) UK Patent Office collections of GB, EP, WO and US patent specifications.

Documents considered relevant following a search in respect of Claims :-
1-38

(ii) ONLINE DATABASES: CLAIMS, WPI

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Category	Identity of document and relevant passages	Relevant to claim(s)
A	WPI Abstract Accession No 93-088242/11 and JP 05/031722 A [1993] (TOYOTA) 09.02.93, see abstract	

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